Work Plan for Preliminary Flow/Solids Monitoring and Sediment Thickness Characterization

Tittabawassee River, Michigan

Prepared for:

The Dow Chemical Company

October 2003

DRAFT

Limno-Tech, Inc.

Excellence in Environmental Solutions Since 1975
Ann Arbor, Michigan

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1. STUDY OBJECTIVES

The Tittabawassee River has been the focus of numerous investigations over the past approximately three decades. These studies have primarily been directed toward gaining an understanding of the distribution of contaminants in river water, sediments, and fish, and more recently, in floodplain soils; and toward developing an understanding of solids transport through the river system. This workplan describes a field effort which will build on previous studies to further quantify the modes of solids transport through the Tittabawassee River, and gain a better understanding of the current inventory and distribution of sediment in the river.

The study described in this workplan is to be performed in two parts: first, a monitoring effort to explore flow and solids transport under varying flow conditions, and second, a poling study to explore the depths of soft sediment throughout the Tittabawassee.

The primary study objectives for the flow and solids monitoring effort are to:

- improve the understanding of solids deposition and transport through the river system; and
- provide preliminary data supporting an assessment of the stability of river and floodplain sediments.

Specifically, the data can be used to help preliminarily determine, at high and low flows, what mass of solids is imported from points upstream of known dioxin contamination areas, gained (from erosion) or lost (to deposition) in each part of the river and floodplain, and/or exported to the Saginaw River.

The second workplan element, a poling and coring study, will be used to determine sediment thickness throughout the river. This work will be conducted in order to provide preliminary data supporting the following objectives:

- determine which parts of the river are currently erosive or depositional;
- determine how sediments of different types are distributed throughout the river, including both fine-grained (typically cohesive) sediments and more coarse-grained (non-cohesive) sediment; and
- find how areas of fine-grained, cohesive sediment correlate with the most and least desirable fish habitat. While this study will not explicitly characterize fish habitat, results will be useful for comparison with other investigations that are more focused on aquatic biota and habitat.

The data collected from each of these workplan elements should assist in the design of the RI workplans that are currently under development as part of the off-site corrective action activities required under the RCRA operating license. Understanding how sediments move between the river and floodplain is a crucial first step in developing a focused work plan for determining the extent, distribution, and fate of dioxin in the sediment floodplain. The study proposed in this workplan will serve as the first step to greatly improve the understanding of sediment dynamics. However, it should be noted that these studies are intended only to provide a screening-level assessment of sediment dynamics, that will serve as essentially an expanded reconnaissance survey supporting future work efforts. A schedule of activities described in this Workplan is included as Figure 1.

2. QUALITY ASSURANCE PROJECT PLAN

A Quality Assurance Project Plan (QAPP) has been developed for the project. The QAPP includes information on project organization, responsibilities, sampling procedures, quality control checks, data management and reporting. The QAPP is included in this document as Appendix A.

3. HEALTH AND SAFETY PLAN

A Health and Safety Plan (HASP) has been developed for the flow and solids monitoring work. The HASP includes safety precaution information and emergency procedures. The HASP is included in Appendix B.

4. FLOW AND SOLIDS MONITORING

4.1. WATER COLUMN FLOW AND SOLIDS

4.1.1. Level Gaging

In fall of 2003, LTI will install 6 electronic level gages along the Tittabawassee. These gages will continuously measure depth in the river and will include locations downstream of each major tributary, in order to measure the incremental gain in flow at each location. Areas of potential importance as flooding or scour areas will also be gaged. Gage locations and a summary of their importance for the study are presented in Table 1. Locations of the gages are also shown in Figure 2. All gages will be located at bridge crossings, for convenience of installation and maintenance, and to allow minimal potential for disruption. Level gages will record depths on a 15 minute interval. Installation will comply with permitting requirements enforced by the local County Road Commission and the State DOT, as required. A 7^{th} level sensing location, currently under investigation, may be added in the Tittabawassee/Saginaw River confluence area downstream.

The level sensing devices to be employed will be pressure transducers with an operating range of 0-35 feet, allowing for events up to the 100 year recurrence interval to be monitored. Gages will be installed in tandem with a conventional staff gage at each location, making it possible for field personnel to check gages manually for potential drift. The devices will be checked on a biweekly basis for good operating conditions, and data will be downloaded and stored on a master database. The devices will allow up to two months of data storage. Specifications for the level sensing devices are included in Appendix C.

The Gordonville Road Bridge depth gage will include a cellular phone and modem device to allow real-time access to level data, for assistance in mobilizing for wet-weather event monitoring. The device will also be programmed to notify Limno-Tech by telephone when flow exceeds an event trigger criterion (described below).

Gaged depths will be referenced to the NAVD 88 vertical datum, and gage elevations will be established by conventional survey techniques, using benchmarks available on or near each of the bridges.

4.1.2. Flow and Solids Gaging

Tittabawassee River discharge statistics are presented graphically in Figure 3. LTI staff will measure flows at each gage during an early fall low flow event (October) and, if possible, a later fall high flow event (November). Flows will be measured using standard USGS techniques (Buchanan and Somers, 1969) employing a bridge board and electromagnetic point velocity meter (Marsh–McBirney Flo-Mate 2000). This flow data will be used to develop initial relationships between stage and flow for each gage. Once the gages are in place and calibrated, the gages will provide a record of stage and flow during high- and low-flow periods. Gage readings will also be made at the USGS gage downstream of the Dow Dam, to allow comparisons with the historical record of data at this location.

Concurrent with the flow gaging work to be performed under early fall low flow and late fall high flow conditions, suspended solids samples will be obtained at the six monitoring locations. Samples will be taken at three time intervals for the low-flow condition, with sampling performed on three repetitions of a circuit starting at the upstream monitoring location and working downstream over a two- to four-hour period. All samples will be taken at the centerline of the river, and samples will be depth-integrated to characterize solids throughout the water column using a DH 76 sampler.

For the high-flow condition, sampling will be performed on the same upstream-to-downstream circuit, with one round performed at or near the beginning of the high-flow event, two rounds at or near peak flow, and one round at the tail of the event. If flow is sufficient to cause significant flooding, water column TSS samples will also be collected in the floodplain area at Imerman Park, between the Tittabawassee Road and State Road instream sampling locations (Figure 4). Samples will be evaluated for total suspended solids (TSS), and total organic carbon, (TOC). Laboratory analytical methods are summarized in Table 2.

Flows in the Tittabawassee River are largely controlled by operations at the Sanford Dam upstream of Midland. The decision to mobilize to capture a wet-weather high flow event will be made based on forecasted rainfall, real-time water surface elevation data upstream of the dam, and coordination with the Wolverine Power Corporation, who operate the dam. Operational decisions for the dam are made based on power generation requirements, reservoir level, and workday scheduling, which can introduce a significant lag between rainfall events and elevated downstream flow (Appendix D). Consequently, scheduling of sampling events will be based in large part on coordination with the dam operators. The fall high-flow condition will be targeted for 100 cms (3,500 cfs) at the USGS gage near the Dow Dam. Mobilization will be initiated when estimated Tittabawassee River flows exceed 80 cms (2,800 cfs) and are likely to increase based on current dam operations and measured/ forecasted precipitation. Sampling will be conducted as soon as possible after mobilization to catch the rising limb of the river hydrograph, and a second round will be conducted after flows have increased to greater than 100 cms. An additional round of sampling will be added if flows continue to increase to a level greater than 120 cms (4,200 cfs). A final round of sampling will be conducted following the event, after flows have returned to within 20% of pre-event conditions.

4.2. FLOODPLAIN STRATIGRAPHIC MEASUREMENTS

In addition to the in-river monitoring activities, preliminary measurements of floodplain sediment deposition will be made using simple floodplain stratigraphic techniques. Deposition will be measured at several locations using a feldspar clay marker horizon technique, which involves introducing a thin stratum of very white feldspar clay to the top of the floodplain soil at a known distance from a geographic marker, to allow future location of the marker site. Small core samples will then be taken from the test pads at future intervals, allowing quantification of the depth of sediment deposited on top of the clay stratum.

Previous studies have shown marker horizons implemented in this way to persist for several years, allowing a long-term measure of floodplain sediment deposition.

Clay marker sites will be located in publicly accessible areas, to allow simple access and to coordinate with previous sampling performed by the Michigan DEQ. Final selection of marker sites will be coordinated with Dow and the MDEQ.

Sample handling and documentation procedures are described in following sections.

5. SEDIMENT THICKNESS CHARACTERIZATION

LTI will conduct a poling study, using a probe to manually estimate the thickness of soft sediment and water depth at transects throughout the 21-mile length of riverbed. Transects will be located at ¼-mile intervals along the river channel. Prior to or concurrent with the probe study, a survey crew will drive vertical steel survey rods into the river bank at each transect location. These survey rods will then be used to fix the location of each transect survey, and to serve as a vertical control against which all measurements of depth will be referenced. The survey rods will also serve as a long-term control against which changes in bed elevation can be measured in future surveys.

Along each transect, the sediment will be probed every 10 feet. Probing will be performed using a graduated 3/8" steel rod. Coordinates of each probe location will be recorded using a GPS unit accurate to <1 meter. At each probed location, a field geologist will record water depth, depth to bottom of soft sediment, and a qualitative description of sediment type and layering based the "feel" of the probe.

Qualitative observations about sediment type made with the probe will be refined by collecting cores at centerline, left and right channel locations. Cores will be collected using 3" lexan tubes and will target depths of 3-4 feet. Using each core, a field geologist on site will visually characterize the sediments at each depth interval as sand, gravel, silt, or clay, with high or low organic content. The actual density of cores collected will depend on judgements made by field personnel on site. For example, if cores are found to be highly uniform in a particular reach, sample density may be decreased until probing and less-frequent coring indicates a change in sediment type.

The tops of all probes and cores will be referenced to the vertical control point located at each transect, with checks against the reference made at the beginning and end of each transect survey. This will ensure the highest possible vertical control under conditions of varying water surface elevations due to operation of the Sanford Dam upstream.

Following physical characterization of the cores, the majority of cores will be extruded and sediment will be left on site. A subset of the extracted cores (every 10^{th} core) will be reserved and held for laboratory analysis of particle size distribution, bulk density, and total organic carbon (TOC) content.

At each transect the field crew will also observe and photograph the shoreline and any submerged vegetation as feasible, to provide future support for mapping of fish habitat. Inspection of the bank will also include probing and recording physical characteristics of the bank soils, at each of the ¼ mile transects. Where access is not restricted, physical characteristics of bank soils will also be characterized using deep probing at the top of banks, using a vibratory hammer drill or geoprobe as required. GPS coordinates of all probes, visual observations and digital photograph index numbers will be recorded on field data sheets.

This task will be performed in early fall 2003, in order to take advantage of low-flow conditions and to avoid hazards associated with intensive river-based field work under cold-weather conditions. The work will be done in two phases: an initial investigation of every 4th transect (1-mile interval) to obtain an overview of the entire river, followed by a second pass to fill in the remaining ¼ mile transects. For each pass, work will be conducted from downstream to upstream, so as to minimize to effects of local disruption of the sediments on subsequent samples.

6. FIELD DOCUMENTATION

6.1. FIELD DATA COLLECTION FORMS

Field log books will serve as a daily record of events, observations, and measurements during field activities. All information pertinent to sampling activities will be recorded in log books. The log books are bound with pages numbered sequentially. Entries in the log book will include:

- Names of field crew
- Date and time of entry and exit
- Location of sampling activity
- Sampling method
- Number and volume of samples collected
- Date and time of collection
- Sample identification numbers
- Field measurements
- Field observations

Surface water field sampling records will be completed for each sample location and will contain information on weather conditions, physical conditions, sample collection times, and sample identification numbers.

Flow meters will be maintained in accordance with the manufacturer's recommendations. Maintenance procedures will be recorded in field maintenance logs.

Field documentation log sheets are included in Appendix E.

6.2. SAMPLE CUSTODY AND DOCUMENTATION

Completed chain of custody forms will be required for all samples to be analyzed. Chain of custody forms will be initiated by the sampling crews in the field during the sampling events. The chain of custody form will contain the sample's unique identification number, sample date and time, sample description, sample type, sample preservation, and analyses required. The original chain of custody form will accompany the samples to the laboratory. Copies will be made prior to shipment for field documentation. A chain of custody form is included in Appendix F. The chain of custody forms will remain with the samples at all times. The samples and signed chain of custody form will remain in the possession of the sampling crew until samples are delivered to the laboratory or the express carrier.

7. SAMPLE COLLECTION, HANDLING AND SHIPPING

7.1. SAMPLE COLLECTION

Sample collection procedures are described in the QAPP in Appendix A. All water samples will be collected as grab samples. Each sample will be collected with a depth-integrating sampler operated in accordance with manufacturer's recommendations. Samples will then be transferred to labeled sample containers.

7.2. SAMPLE HANDLING AND SHIPPING

Samples will be stored at 4 degrees Celsius and delivered or shipped to the Ann Arbor Technical Services Laboratory in Ann Arbor, MI. Shipping containers will be secured with strapping tape. A separate signed custody record will be enclosed in each shipping cooler. All employees will be fully trained in techniques for the proper handling of samples for analysis.

8. DATA QUALITY OBJECTIVES AND REQUIREMENTS

LTI is committed to collecting scientifically valid data that are of the highest quality. This is implemented by ensuring that adequate QA procedures are employed for all data generating activities, as outlined in the Quality Assurance Project Plan. The overall goal of the QA/QC procedures is to ensure that the data collected are complete, representative, comparable, and of a known and documented quality.

A primary element of the field QA/QC program will be collection and analysis of field blanks and replicates. Field blanks and field replicates will be used as quality control checks when sampling water solids content.

Field blanks will be used to monitor potential contamination introduced into the samples by collection and handling procedures. The blank will be generated at the sample collection site by filling an empty sampling bottle with deionized, distilled water. The blank will be returned from the field in a cooler with the regular samples. The field blanks will be collected at a frequency of one per 20 regular samples taken.

Field replicates (or duplicates) will be used to assess the consistency and precision of field sampling and analytical procedures. The replicate will be collected by simultaneously filling a second sample container from the same source as the first, using identical procedures. The replicate will be returned from the field in a cooler with the regular samples. The field replicates will be collected at a frequency of one per every 10 samples taken.

9. REFERENCES

Buchanan, T.J., and W.P. Somers, 1969. Discharge measurements at gaging stations: USGS TWRI Book 3, Chapter A8.

FIGURES

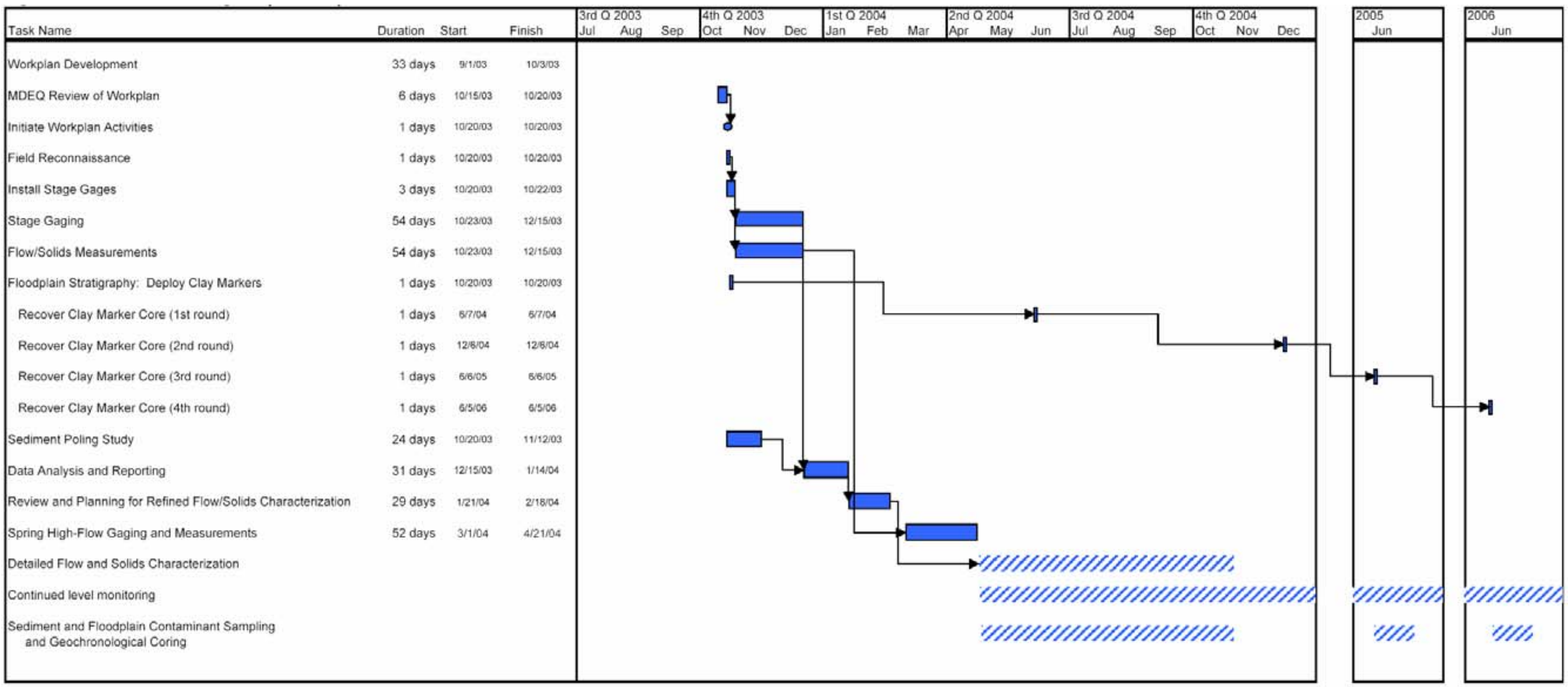


Figure 1. Flow and Solids Monitoring Schedule

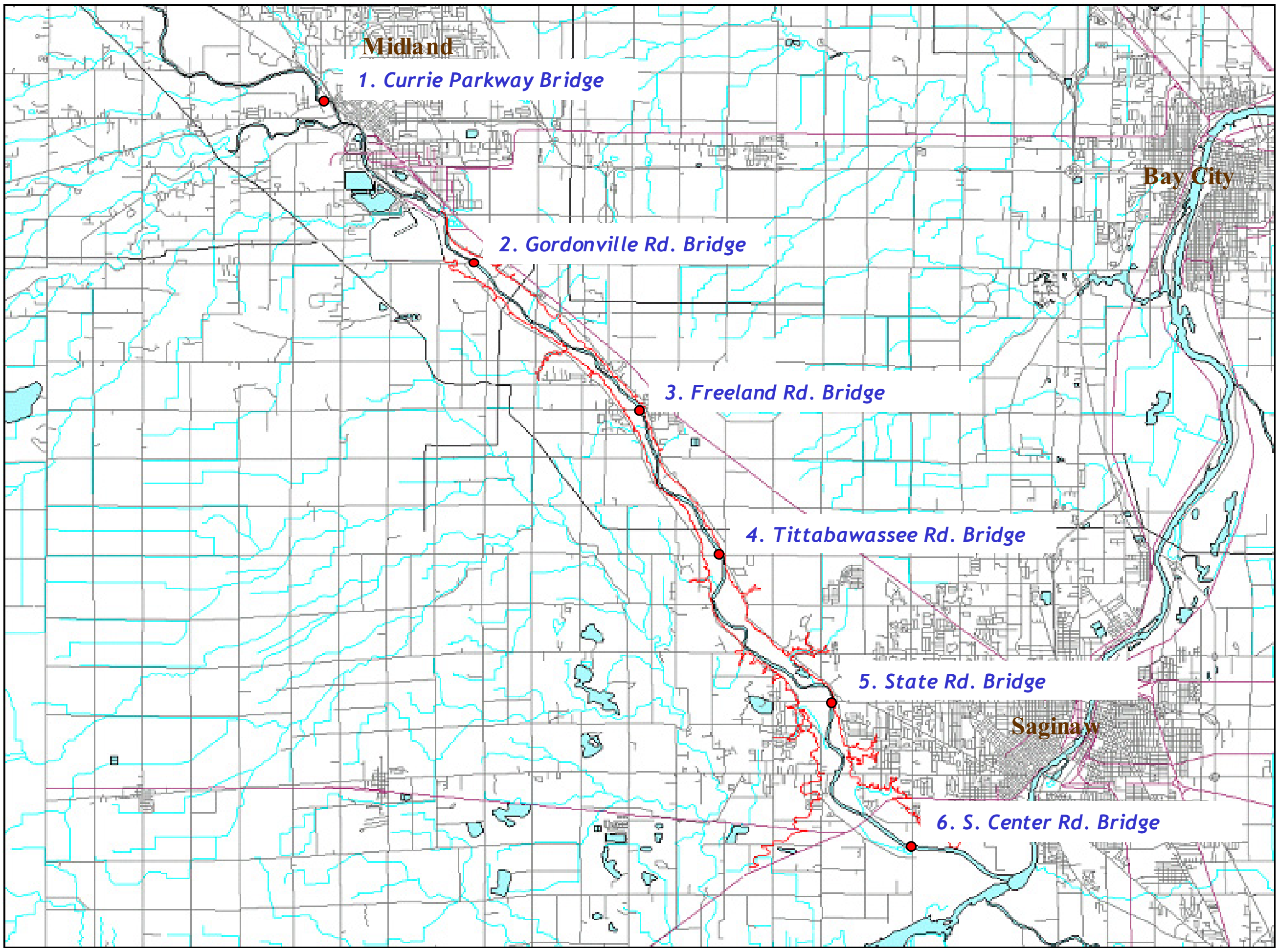


Figure 2. Proposed Flow/Solids Monitoring Locations

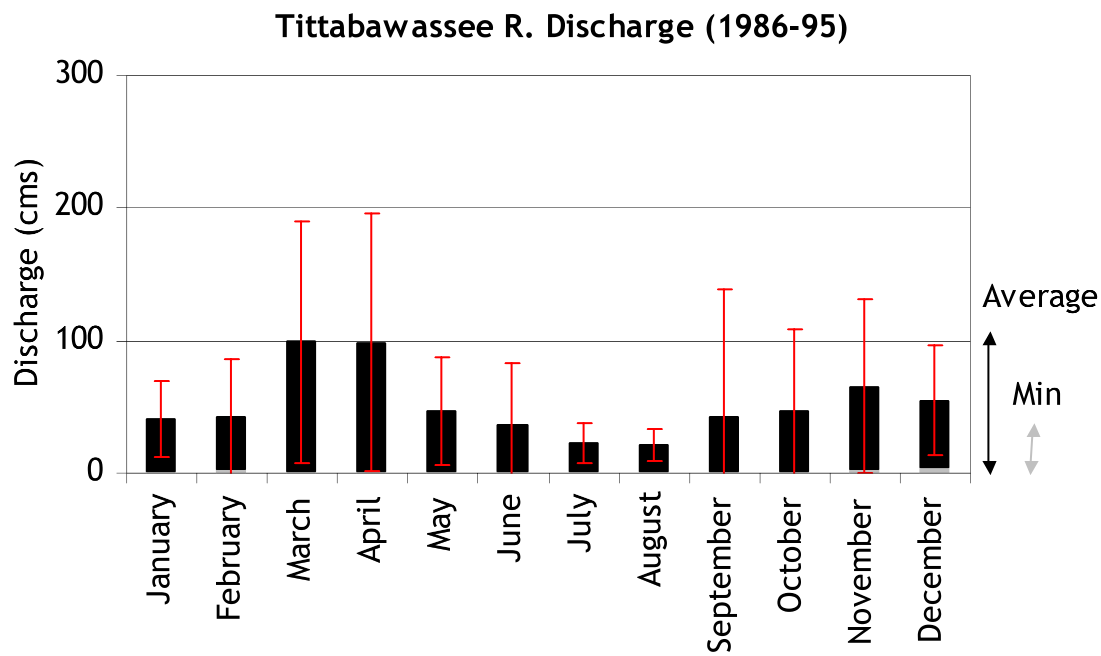


Figure 3. Monthly Tittabawassee River Discharge Statistics

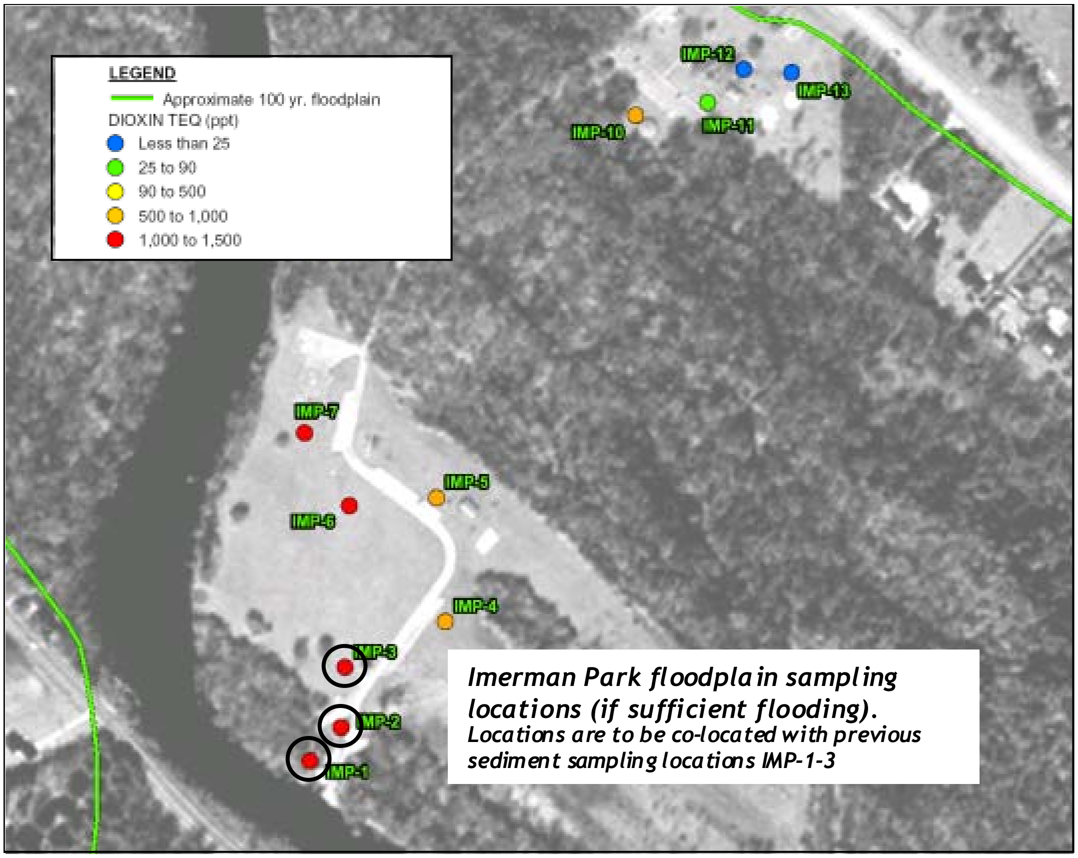


Figure 4. Floodplain TSS Sampling Locations: Imerman Park Detail

TABLES

Table 1. Location of Flow/ Solids Gaging Stations

Station #	Bridge Crossing	RM	Description	Significance
1	Rt. 20	24.0	Riverside Park, just upstream of confluence	Upstream of Dow, Confluence with Chippewa
2	Gordonville Rd.	19.4	At Caldwell Boat Launch	Downstream of Dow, confluence with Chippewa, and Lingle Drain
3	Freeland Rd.	14.6	Town of Freeland	Downstream of Ames Drain, location of historically high sediment TOC
4	Tittabawassee Rd.	11.0	Between Freeland and Saginaw	Upstream of unnamed tributary at RM 8.2
5	State Rd	6.3	W. of City of Saginaw, on river bend	Upstream of 100-year flood backwater, downstream of unnamed tributary at RM 8.2
6	S. Center Road	2.2	S. of City of Saginaw, N. of Shiawassee Wildlife Refuge, just upstream of confluence	Just upstream of confluence, at upstream extent of 100-year flood backwater

Table 2. Laboratory Analytical Methods

Test	EPA Method	Container	Volume	Holding Time	Detection Limit	Preservative
TSS	160.2	HDPE	500 ml	28 days	5 mg/L	none
TOC	415.1	HDPE	40 ml	28 days	2 mg/L	none

APPENDIX A:
QUALITY ASSURANCE PROJECT PLAN

APPENDIX B:
HEALTH AND SAFETY PLAN

APPENDIX C:
LEVEL SENSING DEVICE SPECIFICATIONS

Data recorder specifications:

R-3307 Teloger Specifications

Recorder Channels

Channels	7 total – 3 pulse/event and 4 analog
Memory	128K or 256K RAM total, dynamically allocated among active channels
Analog inputs only	70,560 or 151,200 12-bit values
Pulse inputs only	52,920 or 113,400 16-bit values
Event inputs only	17,640 or 37,800 events
Storage	Wrap-around (first-in, first-out, FIFO) memory

Analog Inputs

Type	Selectable using software
Voltage	Bipolar or unipolar 100 mV, 500 mV, 1, 2, 5, 10, or 20 V full scale, or unipolar 1 to 5 V
Current	Bipolar or unipolar 1 or 20 mA full scale, or unipolar 4-20 mA
Resolution	12 bits (0.025% of FS)
Accuracy	±0.15% (at 23°C), ±50ppm/°C

Analog Sampling

Sample rate	1/s to 1/ 8 h for each channel
Sample interval	1 s to 8 h, synchronized to the hour, channel independent
Values saved	Minimum, average and/or maximum per interval
Totalizers	1 six-byte totalizer per channel

Pulse/event Inputs

Type	Pulse counting or event recording, user selectable
Input	Uncommitted contact or active logic signals
Excitation	10 µA contact sensing current; 5 volt pull-up
Contact bounce	3 ms maximum, software programmable bounce filter

Pulse Sampling

Pulse rate	
Low speed	100/s with bounce filter
High speed	20,000/s with no bounce filter
Total interval	1 s to 8 h, synchronized to the hour, channel independent
Values saved	Totals, overall and per interval

Event Sampling

Event rate	1 event/s maximum
Values saved	Event with time stamp (in mm:dd:yy:hh:mm:ss format), and computed run time

Alarms

Activation	Only with inputs from event or analog channels
Outputs	1 high and 1 low
Type	FET, open collector
Maximum voltage	30 V
Maximum current	100 mA
Resolution	12 bits

Power

Battery type	10-volt lithium battery pack with MTA connector
Battery life	6 months @ 23°C, with 1 sample every 5 s on all channels, no modem
External DC	
Regulated	12 Vdc
Unregulated	15-35 Vdc

Communications

Type	RS-232 compatible (opto-isolated)
Baud rate	9600 baud
Connector	Standard DB-9
Modem option	2400 baud plug-in module, FCC and CSA approved

Mechanical & Environmental

Clock accuracy	± 0.01%
Operating temperature	-20 to 60°C
Enclosure	Bent aluminum panel mount assembly
Size	21.59 cm x 17.27 cm x 5.84 cm / 8.5 "x 6.8 "x 2.3 "
Options	Fiberglass, IEC IP65, NEMA 4X enclosure, contact factory for available sizes and features

Computer Requirements

Computer	486, or higher, IBM compatible computer
Operating system	Microsoft Windows, version 3.1, or Windows for Workgroups, version 3.11, or Windows 95, or Windows NT Workstation, version 3.5 or higher
RAM	8 MB minimum, 16 MB recommended
Monitor	VGA, SVGA recommended
Hard disk space	25 MB minimum available space
Modem	2400 baud or higher

Telogers System Ordering Information

For a Telogers system you will need one or more Telogers, Telogers for Windows support software and a Telog communications cable. Simply call Telog and use the following part numbers for ordering.

R-3307 7-channel Teloger
Order as many as you need.

S-3PC Telogers for Windows
Order one copy for each computer on which you will be working with Telogers.

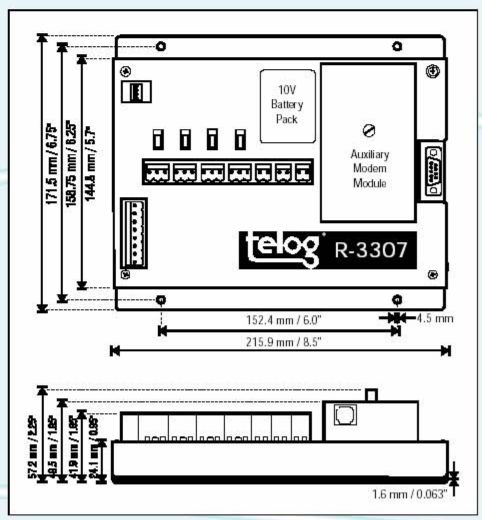
C-21ATC Telog communications cable
Required for any computer-Teloger communications.

There are also replacement parts or optional equipment that you may need.

M-324 Plug-in modem module
Order one for each Teloger that requires telephone communications.

BP-1A Battery pack
A replacement battery pack for a Teloger.

MM-128 Memory module
A factory-installed option to double memory to 256K RAM.



Since we are continually improving our products, the specifications within this brochure are subject to change without notification.

Telog Instruments, Inc.
830 Canning Parkway, Victor, NY 14564-8940, U.S.A.
Phone: 716-742-3000 • Fax: 716-742-3006
e-mail: TelogSales@telog.com

Typical data recorder installation:

Level Sensing Device Specifications:

SSO-31 Specifications

Recorder

Model	Telog PR-31
Type	Single channel pressure recorder
Measurement	
Resolution	12 bits (0.025%)
Accuracy	+/- 0.075% of full scale at 23°C +/- 75 ppm/°C
Temperature range	-40°C to +65°C
Recording	
Sample rate	Programmable from 1/sec up to 8 hours
Data interval	Programmable from 1/sec up to 8 hours
Values saved	Selectable min, avg & max per interval
Memory	128 Kbytes (~80,000 data values)
Interface	
Type	RS-232; 300 to 19.2 Kbaud
Connector	Circular 4 pin watertight
Battery	
Type	Single AA Lithium (Saft LS 14500 or equal)
Life	7 years typical
Physical	
Temperature range	-40°C to +65°C
Environmental	Submersible to NEMA 6 (IP-67)
Enclosure	316 stainless steel
Pressure vent	0.2 micron Gore-Tex filter
Size	140 mm (5.5") long x 45 mm (1.75") diameter
Weight	1 Kg (2.2 lbs)
Support Software	
S-3PC	Telogers for Windows
S-3PCL	Telogers for Windows Lite
Data Transfer Unit	Palm Pilot with Telog support software (contact Telog for Palm specific software)

Sensor

Model	Telog PT-10B
Type	Strain gauge pressure sensor
Range	10 PSI standard (0 to 22 feet of level) (contact Telog for alternate pressure ranges)
Accuracy	
Non-linearity	+/- 0.25% of span; BFSL
Repeatability	+/- 0.03% of span; BFSL
Hysterisis	+/- 0.03% of span; BFSL
Temperature Range	
Operating	-40°C to +65°C
Compensated	-10°C to +65°C
Temperature Effect	
On full scale	+/- 0.02%/°C
On zero offset	+/- 0.02%/°C
Pressure Over Range	
Proof pressure	3 times full scale
Burst pressure	5 times full scale
Physical	
Pressure connection	5/8"-18 UNF female
Sensor length	115 mm (4.5")
Sensor diameter (max)	21.6 mm (0.85")
Sensor weight	170g (6 oz) nominal
Sensor body material	316 stainless steel
Cable	vented polyurethane 6.4mm diameter (1/4")
Cable length	25 feet (contact Telog for alternate cable lengths)
Cable weight	41 g/m (0.027 lbs./ft)

Computer Requirements

For S-3 PC or S-3PCL	IBM compatible computer with a 586/133 MHz or higher processor running on Microsoft Windows 95/98/NT/2000, at least 32 MB of RAM, a hard disk with at least 200 MB of free space and a pointing device.

Telog Instruments, Inc.
830 Canning Parkway, Victor, NY 14564-8940, USA
Phone: 585.742.3000 • Fax: 585.742.3006
E-mail: TelogSales@telog.com • www.telog.com

Specifications within this brochure are subject to change without notification.

APPENDIX D: SANFORD DAM OPERATIONS SUMMARY

Administrative Office
6000 S. M-30
P.O. Box 147
Edenville, Michigan 48620
Tel. (989) 689-3161
Fax (989) 689-3155

WOLVERINE POWER CORPORATION

September 9, 2003

Dr. Noemi Barabas
Limno-Tech, Inc.
501 Avis Drive
Ann Arbor, MI 48108

Dear Dr. Barabas:

Your letter of September 2nd to Glenn MacDonnell has been forwarded to our office for a response. Wolverine Power Corp. operates the four Hydroelectric Dams on the Tittabawassee River, Sanford Dam being the southernmost. I will give you some general operating information for Sanford, you can then call us for more detailed info when you do your field work.

1. Our normal operation during most of the year is to run one turbine for 7 hours, 5 days a week at about 660 cfs. During the remaining 17 hours of the day we open a gate to pass 210 cfs down the river. This off-line spill is a requirement of the Michigan DNR. We do not normally run on the weekends, but maintain the 210 cfs spill. During periods of low river flow we cut back on the number of hours of turbine operation and sometimes decrease the spill to keep the reservoir balanced. During extreme drought periods we sometimes go for 2 to 5 days without turbine operation and cut our spill down to 70 to 100 cfs.

2. We are regulated in our operations by the Federal Energy Regulatory Commission. They have issued a long term operating license to Wolverine, that among other things, stipulates the reservoir level fluctuations we are allowed. The license sets a target level we are to maintain, with an fluctuation allowance of + 0.3 feet and - 0.4 feet. All of our daily and long term operating decisions are aimed at keeping the reservoir level within this 0.7 foot range.

3. During high flows in the river (spring runoff or major rain event) we maintain reservoir levels by putting more turbines on-line and running up to 24 hours a day, 7 days a week. With a surface area of 5,000 acres spread over our four reservoirs, and multiple turbines at two plants, we can control most high runoff conditions without opening spill gates. Sanford has three turbines with a total maximum capacity of 2,150 cfs. If river flows exceed the capacity of the turbines for a longer period than we can accommodate in the reservoirs, we then begin opening spill gates. With three turbines running and all spill gates fully open we can pass about 30,000 cfs at Sanford without overtopping the embankments. Again, all decisions about turbines on-line and opening spill gates are based upon maintaining the target reservoir level.

We keep records of turbine hours and gate openings on a daily basis. This more detailed information is available in our office for your review if you wish to make use of it. Please make arrangements in advance of any visit.

Sincerely,

Frank O. Christie, P.E.
General Manager

APPENDIX E:
FIELD LOG SHEETS

APPENDIX F:
CHAIN OF CUSTODY FORMS